Paralytic Shellfish Poisoning on the Canadian Atlantic Coast*

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IN 1936, Canadian public health officials realized that there was a mussel poisoning problem in Canada when there occurred in Nova Scotia 5 cases with 2 deaths following the consumption of mussels. The facts were reported by Dr. P. S. Campbell, Chief Provincial Health Officer for Nova Scotia, and later reported in a technical paper by Murphy.[1] A special *Bulletin* released recently by the Canadian Government authorities[2] is devoted entirely to the shellfish poisoning problem on the Canadian Atlantic Coast.

One of the earliest references to mussel poisoning is contained in a historical account of Captain Vancouver's expedition entitled "A Voyage to the Discovery of the North Pacific Ocean" published in London in 1798. The reference is to several outbreaks of mussel poisoning with one death among the crew of Captain Vancouver's ship. The incriminated mussels had been collected from an area which is still known as "Poison Cove." The description of the symptoms fits the condition which is now known to be caused by poisonous shellfish. Another interesting reference may be found in the *Washington Exploration Quarterly*, vol. 18, p. 284, in connection with explorations of Alaska by Russians which took place about 1790. In this account, members of a Russian party are reported to have been affected by poisonous mussels, as follows: "One hundred of his hunters were poisoned by mussels from the Peril Straits and died."

There are no cases of mussel poisoning on record in Canada prior to 1936 except the ones just referred to. However, one notable result of careful inquiries conducted in the maritime provinces in 1945 was the revelation of the fact that there have been many unrecorded outbreaks among human beings and domestic animals. It was also found that residents of fishing communities know from old traditions of the dangers of eating poisonous mussels. They have also known that poisoning is confined to definite localities. They have even acquired food habits that afford a certain degree of protection. They will eat, for instance, only the adductor muscle of the scallops, the rim being considered poisonous. Others eat the "red roe" or "coral" as the ovary is called, and regard all other parts of the rim as unfit for food. Although most appreciate the danger of eating mussels, many are still not convinced that soft-shell clams can be poisonous. The allergic form of mussel poisoning has occasionally added confusion in identifying outbreaks. The evident prevalence of limited and hazy notions on this matter is further confirmed by indefinite reports of cases. Thus, in 1937, 1 case may have occurred at Pocologan, New Brunswick, and there were probably 2 deaths

* Presented at a Joint Session of the Laboratory and Engineering Sections of the American Public Health Association at the Seventy-fifth Annual Meeting in Atlantic City, N. J., October 7, 1947.

years ago at Hailey's Cove, N. B. There was also another report from this locality in 1936, that probably 3 cases had occurred following the consumption of blue mussels.

Following the Digby outbreaks, some investigations were carried out and the seriousness of the problem was revealed.[3] Since 1943 surveys have been conducted without interruption in order to determine the danger season, the dangerous areas, and the dangerous species of shellfish. This was successfully accomplished with the collaboration of the Fisheries Research Board of Canada and the Dominion Department of Fisheries. Sampling programs were drawn up and included all of the commercial clam areas as well as the canning and the shucking plants. The results obtained led to the institution of a quarantine regulation whereby areas showing toxicity increasing above a certain level may be closed immediately to fishing. Under this authority, also, the packs of canning and shucking plants may be subjected to regular or periodic sampling for the detection of mussel poison. These measures have already proved their efficiency. The consumers of clams and other shellfish of the home trade as well as the export market are now assured of a perfectly safe food in all its popular forms. This beneficial result, on the other hand, may be expected to reflect on the Canadian shellfish fishery by guaranteeing a steadily increasing market.

The detection of mussel poison is effected by a simple test which was developed from the "field test" used by Sommer and Meyer.[4] Briefly the steps are: mincing the washed shellfish meats; suspending a determined portion of the mince in an equal volume of tenth normal hydrochloric acid and boiling gently for 5 minutes. The mixture is made up to the original total volume with distilled water, the pH adjusted to between 4.0 and 4.5, and then centrifuged or permitted to settle. The clear supernatant liquid is injected intraperitoneally into at least three white mice. The mean death time is referred to a standard toxicity graph from which toxicity is determined and expressed as "mouse units." The mouse unit is the amount of poison, contained in 1 ml. of extract, that kills mice of 20 gm. weight in 15 to 20 minutes.

The quarantine level has been set at 400 mouse units, and was first based upon the work of Sommer and Meyer.[4] The effectiveness of this level in affording consumers a more than ample degree of protection is now well established. Epidemiological studies carried out in 1945 in the maritime provinces have shown that the mildest symptoms of poisoning may be observed only when a quantity of poison in excess of 1,000 units has been ingested, thus confirming the 400 mouse unit quarantine level.

The epidemiological study referred to above was carried out in 1945 and has been reported in the literature.[2] An outstanding feature of this study is that case records included the place of origin of the poisonous shellfish as well as the date they were fished. It was thus possible to correlate toxicity of raw shellfish, dosage of poison, and symptoms. The data indicated that the minimum amounts of poison required to produce mild, severe, and extreme symptoms of poisoning in susceptible persons might be in the neighborhood of 2,000, 10,000, and 25,000 mouse units respectively. The clinical picture was carefully studied in the 28 human cases in New Brunswick in 1945. The symptoms, varying in severity with the amount of poison ingested, were consistent; numbness about face and mouth, "pins and needles" feeling about the lips, vomiting, headache, dizziness, difficulty in breathing, general weakness, occasional paralysis. The poisoning of domestic animals, particularly hens and house cats, seems to have been quite

common. More frequent illness among human beings is apparently prevented by the food habits of the people in the fishing communities and their traditional knowledge of the dangers involved. It was also found that there were many who ate toxic shellfish without ill effects. These cases were of particular interest since they indicated a degree of human resistance to the poison. This was found especially among inhabitants of shore communities. Most of the sufferers were among non-residents of these communities such as picnickers, for whom shellfish were not a habitual item of diet.

All of the species of mollusks more or less generally favored in the Bay of Fundy areas have been found toxic to some degree, during the late summer and early fall. These comprise, in decreasing order of toxicity, the red mussel *(Modiola modiolus)*, the blue mussel *(Mytilus edulis)*, the bar clam *(Mactra solidissima)*, the razor clam *(Ensis directus)*, the scallop *(Placopecten grandis)*, and the soft-shell clam *(Mya arenaria)*. The last mentioned is the most important commercially and, fortunately, is the least dangerous.

The distribution of the poison within the shellfish was found to vary considerably with the organs. While Pugsley[5] demonstrated the poison to be centered in the siphon of the butter clams *(Saxidomus)* of the West Coast, the toxicity records of the Atlantic Coast mollusks show that the poison is most concentrated in the liver. The gill is next in importance, and the remaining parts come in third place. The soft-shell clam *(Mya)*, however, was shown to undergo a seasonal reversal of conditions, the liver having the highest toxicity level during the summer but ceding its place to the gill during the fall and winter months. Muscle tissue in all species was shown to have a low capacity for the poison; in the case of the scallop, however, there was never any trace of poison demonstrated in the adductor muscle, a most fortunate circumstance indeed, considering the popularity of this part of the scallop as a delicacy.

With regard to the location of toxic beds within any given area, the toxicity was found to increase from nil to high levels with the proximity to the open sea. This is indeed a boon for the industry since most of the main commercial beds may be left open to fishing with little or no risk. Such is the case in Passamaquoddy Bay, where the inside areas have been consistently free of poison. Farther along the New Brunswick side of the Bay of Fundy, the commercially important areas that are open to the bay itself had the highest toxicity levels. These have been closed to fishing. Many commercial clam areas in Nova Scotia have been demonstrated to be free of poison, and all areas in Prince Edward Island and along the Northumberland Strait have also been found safe.

The ultimate source of the poison has been shown to be in a species of dinoflagellate *Gonyaulax tamarensis*, one of the planktonic organisms on which the shellfish feed. The appearance of high toxicities and large numbers of the dinoflagellate have been simultaneous, that is, between mid-July and the end of September.

Attempts to devise means of destroying the poison were the object of numerous experiments. In that regard, the chief of these were to determine the effects of domestic cooking, shucking, and commercial canning. Domestic cooking experiments included steaming for 15 to 20 minutes in a covered pot with only sufficient water to cover the bottom; boiling in water for 20 minutes; and "pan-frying" for 15 minutes in an open pan with just enough fat to prevent burning. Although these cooking processes were found to reduce the poison content of the raw meat by at least 70 per cent, they were demon-

strated to fall short of providing sufficient protection.

While shucking was demonstrated to have no effect whatever toward reducing the poison content of clams, the process of canning, as it is practised commercially, was found to be quite efficient. Presumably certain factors forming part of the process, such as discarding clam bouillon, the alkaline condition of steaming and the retorting temperature are jointly responsible in reducing a raw meat toxicity of 1,000 mouse units to a safe level. This protection is effectively insured by sampling systematically all commercial packs when the toxicity in clam fishing grounds rises over the quarantine level of 400 mouse units, and releasing these packs for sale only if free of demonstrable poison.

Commercial fishing of mussels of any species from areas in the Bay of Fundy either for canning or for sale as raw food has been prohibited at all seasons since the autumn of 1943, when their toxicity was found to be several times higher than that of clams.

The scallop industry presents no problem since the adductor muscle, the only part marketed, has been demonstrated to be consistently free of poison.

During the past three years, the Department of Fisheries, on recommendation from the Department of National Health and Welfare, has imposed temporary restrictions on the taking of shellfish from restricted areas. At such times the grounds have been closed to all fishing except for canning. Dangerous areas have been posted with warning signs and patrolled by special wardens at week-ends when picnickers visited them. Beyond this, there is little that can be done to enforce the fishing prohibition on the general public. On the other hand there has been no difficulty in maintaining good control of all commercial operations.

REFERENCES

1. Murphy, C. I. Mussel Poisoning in Nova Scotia. *Canad. M. A. J.*, 35:418–419, 1936.

2. Medcof, J. C., Leim, A. H., Needler, A. B., Needler, A. W. H., Gibbard, J., and Naubert, J. Paralytic Shellfish Poisoning on the Canadian Atlantic Coast. *Bull. LXXV, Fisheries Research Board of Canada*, 1947.

3. Gibbard, J., Collier, F. C., and Whyte, E. F. Mussel Poisoning. *Canad. Pub. Health J.*, 30:193–197, 1939.

4. Sommer, H., and Meyer, K. F. Paralytic Shellfish Poisoning. *Arch. Path.*, 24(5):560–598, 1937.

5. Pugsley, L. I. The Possible Occurrence of a Toxic Material in Clams and Mussels. Fish. Res. Bd. Can. *Prog. Rep.* Pacific Station, 40:11–13, 1939.